

## CONTROLLING AIR LEAKAGE

Sealing your home against air leakage is not difficult. Reasonably handy homeowners should be able to do an effective job if they have the time and patience, and are conscientious about sealing areas that may be difficult and uncomfortable to work in. This is particularly true if the homeowners have had a blower door test done because that is the best method available to identify air leakage areas. This chapter describes the basic materials and techniques for controlling air leakage in your home.

### Before You Begin: Health And Safety

Remember your home is a system of interacting components. Changing one thing often affects another. Tightening the house against air leakage is a good example of this. Before beginning any air sealing work, you should consider potential effects on the rest of the house. Two important considerations are combustion appliance safety and indoor air quality.

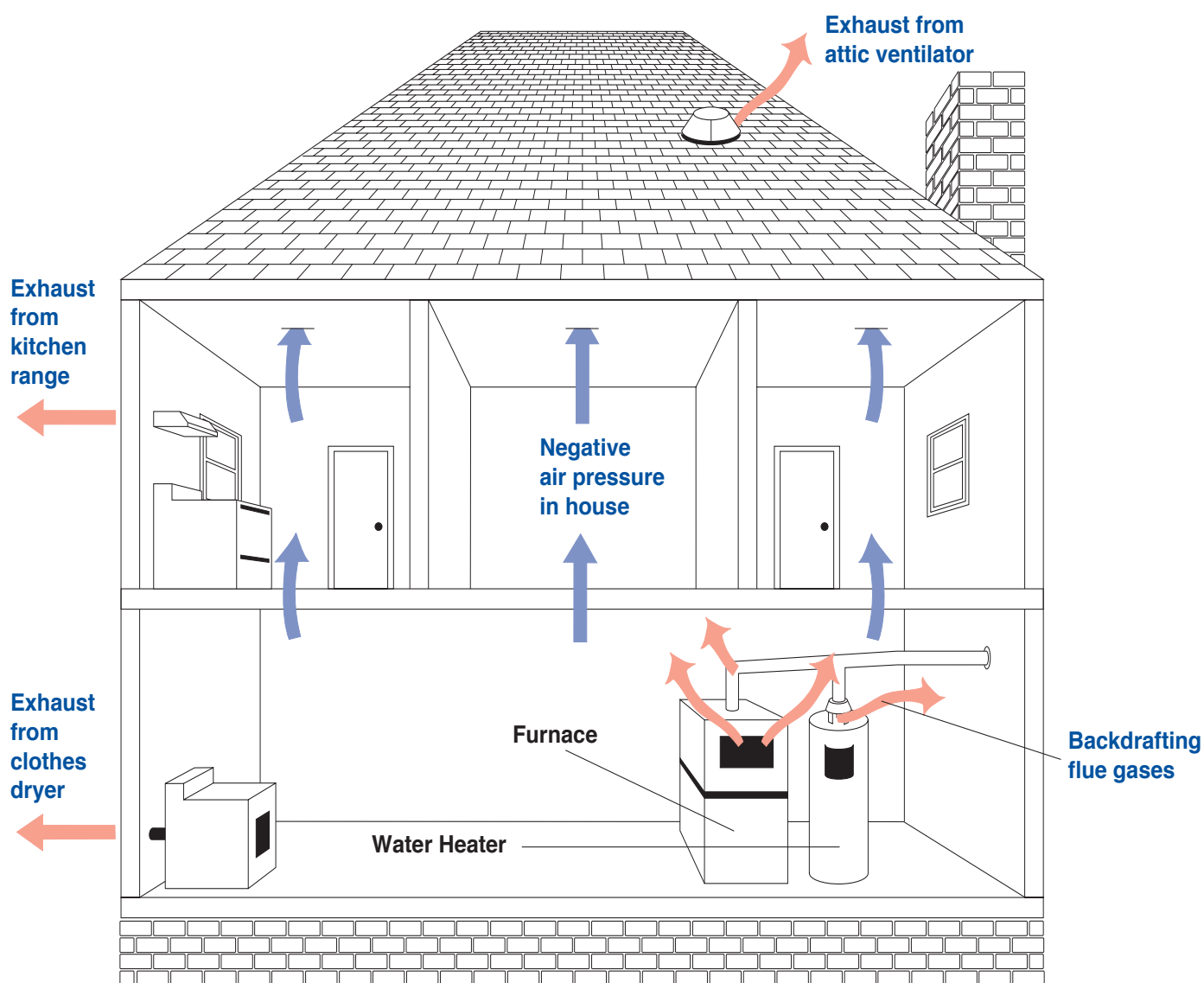


Figure 2-1 - Exhaust from other appliances can impede the proper venting of fuel-burning appliances.

## Combustion Appliance Safety

If your furnace, boiler or water heater burns gas, oil, coal, or wood, you should check to make sure that tightening up the house will not interfere with proper venting of the flue gases.

Some combustion appliances depend on natural buoyancy to carry warm flue gases up the chimney and out of the house. Such appliances, called "natural draft" or "atmospheric vented", always vent into a vertical flue -- either a masonry chimney or metal flue -- and have a "draft hood" which draws in extra indoor air.

When other exhaust appliances such as clothes dryers or kitchen fans are running, they may create a negative pressure in the home which can cause flue gases from natural draft appliances to spill back into the house, creating a potential health hazard (Figure 2-1 on page 17). Tightening the house by sealing air leaks can make this situation even worse. This is why it is important to consider the value of a blower door test not only to identify air leakage but to also make sure that air sealing has not made the house too tight.

If you have natural draft appliances in your home, you must make sure that there are no potential safety hazards before embarking on an air sealing program. One simple test is to close all exterior doors and

windows and turn on all exhaust appliances in the house including bath fans, clothes dryers, attic fans, central vacuum cleaners, etc. Then turn up your thermostat to activate the furnace and run hot water to activate the water heater. Using a smoke stick or incense, check whether the exhaust flue gases are flowing freely up into the chimney (Figure 2-2). If not, you have a potentially hazardous situation and should forego any air sealing work unless it can be corrected.

The best method to check draft is to have a professional draft test performed. Most heating contractors, weatherization professionals, and home inspectors can perform this test. It is extremely important that all combustion appliances in the home be tested for proper draft and venting before any air sealing work is started. If the professional that you hire is not using any equipment to test draft or is simply using a flashlight and a cigarette lighter then the test is subject to inaccuracy and an unsafe situation may not be recognized.

It is equally important to re-test natural draft appliances after all air sealing work is completed. Once again, to ensure the safety of you and your family, it is best to have this testing done professionally. Remember, because your house is a system, tightening the shell may significantly impact how the mechanical equipment operates.

## Carbon Monoxide: The Silent Killer

Carbon Monoxide (CO) is the leading cause of accidental poisoning deaths in America. It is a colorless, tasteless, odorless, toxic gas that is produced by the incomplete combustion of fuels. All fuel burning appliances - gas, oil, wood, or coal furnaces, un-vented space heaters, fireplaces, gas water heaters, etc. - have the potential to produce carbon monoxide. Early symptoms of CO poisoning are headaches, nausea, dizziness, shortness of breath, and confusion - symptoms that resemble the flu. If you feel better when you leave the home and then experience these same symptoms when you return then this is a sign that there may be dangerous levels of CO in the home. Table 2-1 on page 19 shows some of the effects of breathing low levels of carbon monoxide. Sensitivity to carbon monoxide varies from person to person; children, seniors, and people suffering from certain conditions tend to be affected more quickly and at lower CO levels.

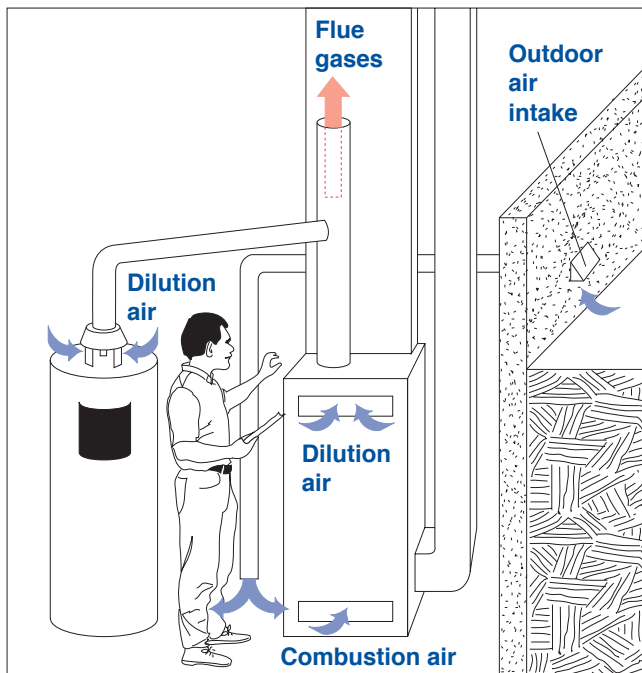


Figure 2-2 - A simple spillage/backdraft test.

**Table 2-1 Effects of Breathing Carbon Monoxide**

CO Concentration in Air	Results
12,800 parts per million (1.28%)	Headache, nausea Loss of consciousness Death within 1 to 3 minutes
1,600 parts per million (0.16%)	Headache, nausea within 20 minutes Loss of consciousness Death within 1 hour
8,000 parts per million (0.08%)	Headache, nausea Loss of consciousness Death within 2 hours
400 parts per million (0.04%)	Headache, nausea after 1-2 hours Loss of consciousness Death after 3 hours
50 parts per million (0.005%)	Maximum continuous exposure over 8-hour period (Occupational Safety and Health Administration)
9 parts per million (0.0009%)	Maximum acceptable indoor air quality (Environmental Protection Agency)
0 parts per million (0%)	Desirable level
The effects of short, low level carbon monoxide exposure are quickly reversed as soon as the victim is moved to an area with fresh air. Victims who lose consciousness, however, may sustain brain damage.	

A house that is too tight or a house that has negative pressure conditions as a result of equipment (such as dryers or exhaust fans) sucking air from the home can cause backdrafting of combustion appliances. If the chimney is blocked or dirty, if vent pipes are dirty or

disconnected, and/or if the furnace is not operating correctly, carbon monoxide may be spilled into the living space. These are reasons to have a regular maintenance check of your heating system and to be sure that all combustion appliances and chimneys are drafting and venting properly. This is particularly true if air-sealing work is being done to the home.

It is absolutely imperative that any home with combustion appliances also have a UL-rated carbon monoxide detector installed. These inexpensive detectors are available in hardware and variety stores, and are installed much like smoke detectors. They sound a loud alarm if CO levels become dangerously high.

## Power vented appliances

Some furnaces, boilers, and water heaters are "power vented", meaning they use a small blower to exhaust flue gases from the house. Flue gases from power vented appliances rarely spill back into the house. The newest furnaces and water heaters use completely "sealed combustion" which means they bring in outdoor air for combustion through an intake pipe and vent flue gases back out through a second pipe. Because they are completely isolated from the indoor air, these appliances are generally immune to backdrafting. If you have only power-vented equipment, you need not be as concerned with spillage or backdrafting hazards. But these systems should still be tested for proper draft because any venting system can become blocked or defective.

## Indoor Air Quality

We consumers are continually bringing new products into our homes, many of which give off chemical vapor into the air. Even in a leaky house, these pollutants may build up in the air, possibly enough to become unhealthy. Tightening your house only makes it more difficult for such vapors to escape, increasing the potential health risks.

The Environmental Protection Agency ranks poor indoor air quality among the top five environmental risks to public health. Air pollution within the home can be significantly higher than levels of pollution outdoors.

Americans spend as much as 90% of their time indoors. A house that is too tight or that has improper ventilation can cause and contribute to long term health problems.

An airtight house can hold in moisture as well, another potential problem. Excessive indoor humidity can cause mold and mildew growth and even structural decay.

Aside from obvious sources of air contaminants, such as paint cans, strong cleaning solutions and other chemicals, there are a few other things to check for as listed below:

### Biological pollutants

Molds, mildew, fungi, bacteria, and dust mites are some of the main biological pollutants found inside the home. These pollutants thrive in areas of excess moisture and can be easily distributed by vacuuming. Allergic reactions and asthma attacks are the most common health problems associated with biological pollutants. Identifying the causes of excessive moisture is the first thing that should be done to destroy the habitat for these pollutants. Using vacuums with high efficiency filters and being sure to keep all humidifiers, dehumidifiers, and air conditioning coils clean is very important as well. The best treatment is to insure that there is adequate ventilation within the home. Air sealing a house is still appropriate but being sure that the house is not so tight that indoor pollutants are made worse is very important. If necessary, pollutants can be controlled through mechanical ventilation.

### Asbestos

Asbestos is a very common building material that was used extensively up until the late 1970s. It can be found in some types of insulation, ceiling tiles, floor tiles, wallboard compound, asbestos siding, and duct and boiler wrap. Asbestos can cause cancer if the exposure is long term and/or excessive. The important consideration here is that if you are doing any remodeling or air sealing that may disturb asbestos related products then you are creating a health risk in your home. If there is any doubt about disturbing something that may have asbestos in it, be sure to seek professional help and have that material tested for asbestos content. Always follow prescribed and safe methods of removing and disposing of any material that may contain asbestos.

### Lead Dust and Formaldehyde

Lead was used extensively in house paint until 1978. Lead dust is a problem if the paint is in poor condition or while doing remodeling or air sealing work in which the paint is disturbed. Water can also be a problem due to the lead contained in solder, fixtures, and piping. Young children are particularly affected by lead and even a small amount ingested can cause significant health problems. Before replacing those inefficient single paned windows in a house that is over twenty years old, have the paint tested for lead.

Formaldehyde is a preservative, adhesive, and sealant that is commonly found in pressed wood products such as paneling and particle board. Formaldehyde can cause a wide range of health problems. Be sure, when doing any energy remodeling that may be disturbing products with formaldehyde, that you wear an appropriate dust mask, have an adequately ventilated work area, and do a thorough clean up when the work is done.

### Volatile Organic Compounds

Volatile organic compounds (VOCs) are organic chemicals widely used as ingredients in household products. These products can include:

**Paints**

**Solvents**

**Aerosol sprays**

**Cleansers**

**Disinfectants**

**Automotive products**

**Adhesives**

**Stored fuels**

All of these products can release organic compounds while you are using them and when they are stored. These pollutants can cause a variety of health problems including cancer. To reduce exposure to VOC emissions, use the products according to manufacturers instructions, always use in well ventilated areas, store in well ventilated areas that are not in the household, close containers tightly, and do not store for long periods of time.

If you are storing these products in the household and

the house is not properly ventilated or is too tight to begin with then you are maximizing the problem. Never store VOCs in any area that may be subject to a leaky return duct. A leaky return may suck these organic compounds into your duct system and distribute these pollutants throughout the home. (See Chapter 5).

## Mold and Moisture

Mold is part of our natural environment and plays an important role in the natural decaying process. But molds should not be allowed to grow indoors because they produce allergens, irritants, and even potentially toxic substances. There are many types of mold which have different characteristics but the one thing that they all have in common is that none of them will grow without water or moisture. Therefore, mold can be controlled by reducing indoor moisture. If there is mold growth in the home, clean up the mold but fix the water and/or moisture problem as well, or the mold will simply return.

Air sealing a home that has a moisture problem can very easily make matters worse. A leaky house can also have moisture problems but tightening a home without first correcting the source of excessive moisture is a mistake. Things to look for that may be causing mold and moisture are:

- Fix all water leaks including plumbing leaks, faucet leaks, roof leaks, and any water entering the basement or crawl space.
- Clean and repair roof gutters regularly and be sure that gutters are directing water away from the home.
- Keep air conditioning drip pans clean and drain lines unobstructed.
- Be aware of excessive condensation on windows. This can be a sign of a moisture problem. (See Chapter 4.)
- Make sure that all vent appliances that produce moisture, such as clothes dryers, stoves and furnaces are vented properly to the outside.
- Unvented space heaters like kerosene heaters and unvented gas heaters and fireplaces produce tremendous volumes of moisture and these units should be avoided.
- Seal all thermal bypasses that can move warm air through the house and cause moisture to condense on cooler surfaces.

- Use air conditioners and dehumidifiers when needed.
- Make sure that all bathroom and kitchen exhaust fans are working properly or open windows when needed.
- Be sure that your walls and attic are insulated properly. Gaps in insulated areas can cause moisture problems.
- Have your duct system inspected for moisture and mold growth. A leaky duct system can result in moisture condensation and mold growth. The duct system will then distribute the mold and moisture throughout the house.
- Check the relative humidity in your home. Kits and meters for measuring humidity levels are sold in hardware stores and in home electronics stores. Relative humidity should be between 30 and 60% when the house is heated or air conditioned. If it is greater than this, find the source of the excessive moisture. (Be sure that you are not over-using a humidifier in the home.)
- In some summer weather, high humidity levels are unavoidable without air conditioning. In very humid summer weather you should be on the alert for mold and mildew growth.

### *Do you have any unvented gas or kerosene space heaters in the home?*

Unvented space heaters give off carbon dioxide, water vapor and, when not working properly, carbon monoxide and other chemical pollutants. If you are using unvented fuel-burning space heaters, you should postpone house tightening until they are removed.

### *Do you have a gas cook stove? Gas stoves give off a lot of water vapor.*

The oven gives off some carbon monoxide on startup and can give off much more carbon monoxide if the stove is not working properly. Gas stoves should be vented to the outdoors through a power-vented range hood. If your gas stove is not vented, you should forego extensive house tightening.

### *Do your bath fans work properly?*

The best way to control indoor air quality is to remove the contaminants, including moisture, at their



source. Your bath fans provide an excellent opportunity to ventilate moisture and other pollutants at minimal cost.

As part of your air sealing project, you should make sure your bath fans are working. Hold a stick of incense below the fan to see whether it pulls the smoke from the room. Try it with the bathroom doors open and closed. If the fan works only when the doors are open, you will need to undercut the doors to allow air into the bathroom.

If the fan doesn't work under any conditions, you should replace it.

## Adequate Air Exchange

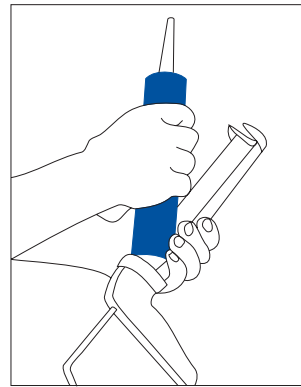
Air sealing or tightening a home is a good step towards making a home more energy efficient, but a house that does not have adequate air exchange or natural ventilation may cause health and safety problems. A blower door test is a recommended tool in checking for adequate air exchange. If air exchange is inadequate the best remedy is mechanical ventilation, which can control the intake and exhaust of outside air and provide the necessary air exchange even if a house is tight. A tight house is an energy efficient house and can be a healthy house if there is adequate air exchange.

This is another area where a heating contractor, energy auditor, or "house doctor" can provide expertise. If you are concerned about indoor air quality issues and how air sealing may affect this, seek professional help.

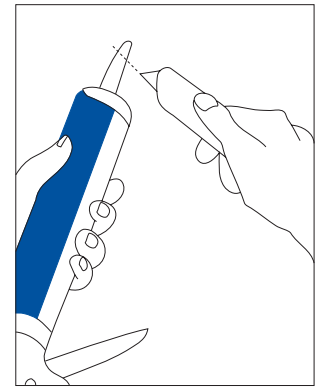
In houses sealed to very low leakage levels, homeowners and builders sometimes install "air-to-air heat exchangers." These heat exchangers draw outside air in and exhaust inside air while transferring heat from one air stream to the other. They bring fresh air into the house without wasting energy and allow very high levels of energy efficiency. In any home with fuel-burning equipment, however, their installation should be planned by a professional.

## Air Sealing Materials

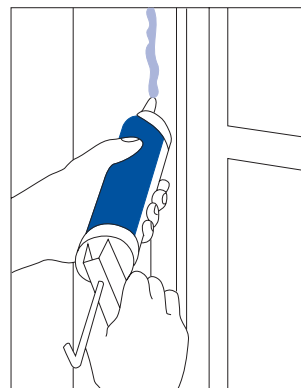
Different types of cracks or holes require different materials for sealing. To fix large leaks and bypasses, you'll need an assortment of rigid materials, sheet materials and expanding foam sealant. To seal smaller cracks and seams, you'll need an appropriate type of caulk. To tighten windows and doors, you'll need the appropriate weatherstripping. Finally, you may need some specialty items, such as high temperature sealant and two-part foam products for sealing around chimney flues, fireplaces and thermal bypasses.



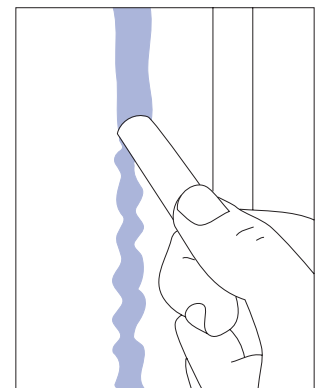
**1. Place tube in caulk gun as shown; pull trigger several times to tighten plunger against tube.**



**2. Cut end of nozzle at 45° angle. A 3/8-in. opening is right for most jobs.**



**3. Place nozzle against seam. Slant gun 45° in direction it will travel. Squeeze trigger gently for even flow.**



**4. To ensure a neat finish and firm contact on either side of a seam, smooth fresh caulk with a stick, or suitable tool.**

*Figure 2-3 - How to Apply Caulk*

**Table 2-2 - Types and Properties of Caulking Compounds Suitable for Air Sealing Work.**

GENERIC TYPE	COST	USEFUL LIFE	COMMENTS
Oil-base	Low	3-5 years	Poor adhesion to wet surfaces. Considerable shrinkage. Generally not recommended.
Butyl Rubber	Low to Medium	3-10 years	Good adhesion to masonry and metal; poor adhesion to wet surfaces. May be stringy during application. Long curing time before paintable.
Acrylic Latex	Low to Medium	10-20 years	One of the best all-purpose caulks. Paintable. Easy to use. Cleans up with water. Resilient and crack-resistant. Bonds well to wood and other porous substrates.
Silicone	High	20-50+ years	Excellent flexibility. Good adhesion to most materials. Effective over very wide temperature range. Easy application. Most are not paintable. May not bond well to all woods.
One-part Polyurethane	High	20-30 years	Excellent adhesion to most surfaces. Very good performance. Paintable. Clean-up may be difficult.
Ethylene Copolymer	Medium	20 years	Good adhesion to most materials. Good flexibility. Paintable. Good general-purpose caulk.
Polyurethane Foam Sealant	Medium	10-20 years	Good for filling large cracks but does not move well. Not recommended outdoors.
Solid caulking or "rope caulk"	Low	2-3 years	Clay-like material sold in coiled lengths. Used mostly as a temporary seasonal sealant at places like window sashes and unused doors.

## Caulk

Not all caulks are the same. Some are paintable; some are not. Some tolerate joint movement; some don't. Different types stick to different surfaces. Some caulks, for instance, cannot be used on masonry. Finally, the life expectancy of different caulks varies considerably. When selecting the caulk for a specific task, be sure to choose one that is suitable in all of these respects. Check manufacturers' recommendations for the surfaces and tempera-

tures on which it can be used and for any limitations.

Table 2-2 above presents a summary of general properties of the most common types of caulk.

## Weather stripping

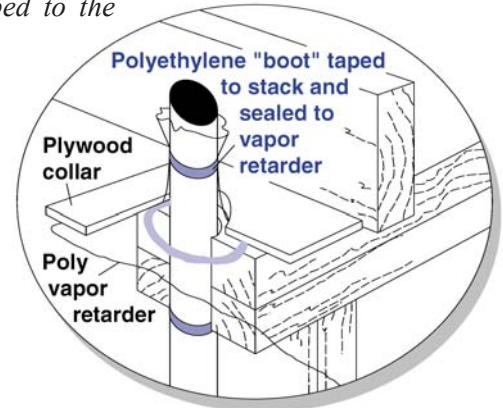
See Chapter 4 for information on weather stripping products and techniques.

## Attic Work

### Plumbing stacks

Figure 2-4 - Plumbing stacks expand and contract as hot water is used in the house, so the air seal must allow for some movement. Professional contractors often use a special neoprene gasket made for the problem. Ordinary polyethylene clamped or taped to the stack and stapled to the attic floor will also work

Figure 2-4



### Ductwork penetrations into attic

Figure 2-5 - Seal all duct penetrations into the attic with caulk, duct mastic, or expanding foam. This includes kitchen and bath exhaust fans as well as heating and cooling distribution ducts.

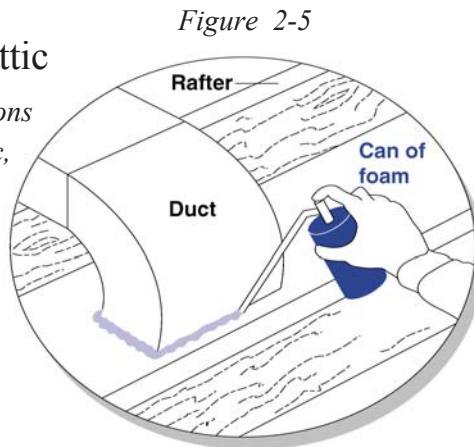


Figure 2-5

### Tops of balloon-framed walls

Figure 2-6 - You can either seal the tops of balloon-framed walls with heavy cardboard caulked and stapled into place, or with other rigid air barrier materials.

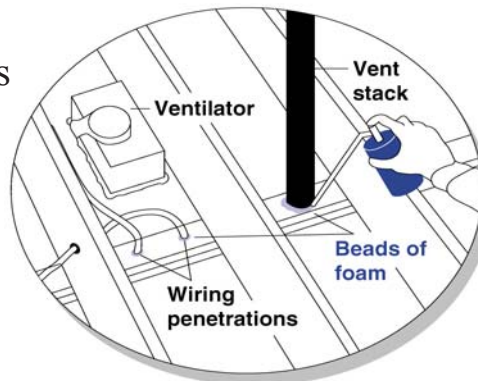


Figure 2-6

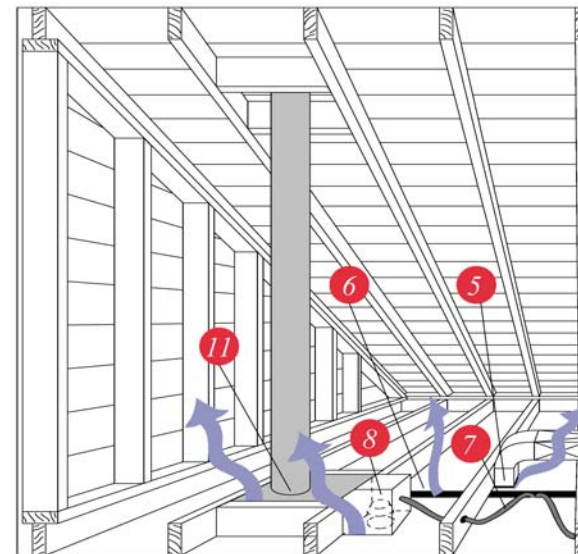
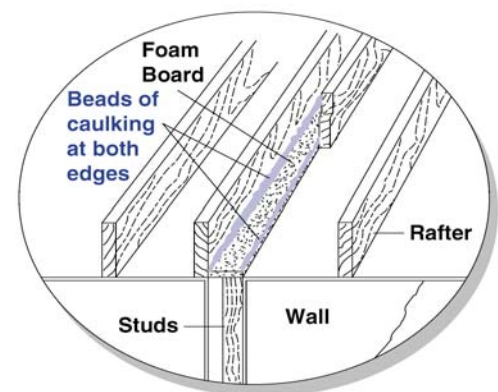


Figure 2-7

### Top plates of interior partitions

Figure 2-7 - Seal all wiring and other penetrations in partition top plates with caulk or foam. Also, check the joint between the interior partition and ceiling drywall. If there is a visible crack that might allow air leakage, caulk the seam. (This is sometimes a difficult area to assess without using a blower door.)





## Chimney chase

*Figure 2-11 - The gap between the chimney and its framing sometimes extends all the way through the house, down to the basement. It should be sealed with a metal flashing that is nailed to the attic floor joists and caulked to the chimney using high temperature caulk.*

Figure 2-11

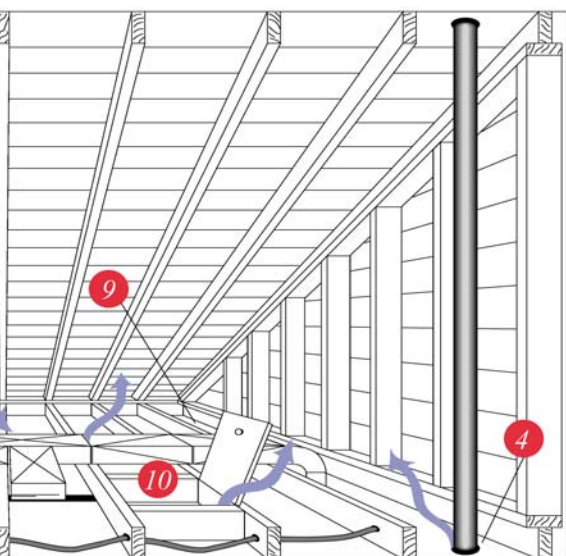
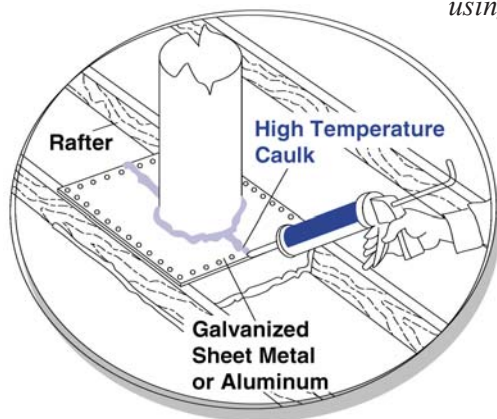


Figure 2-8

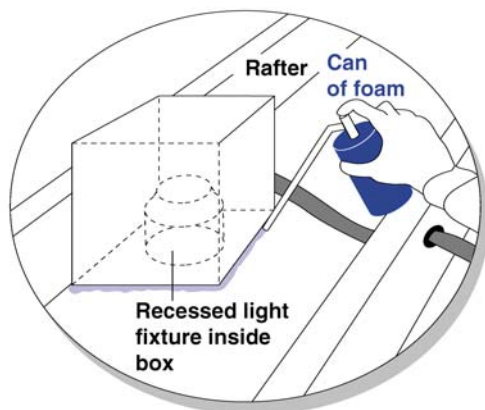
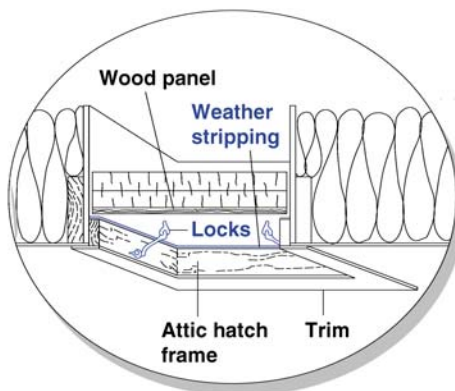


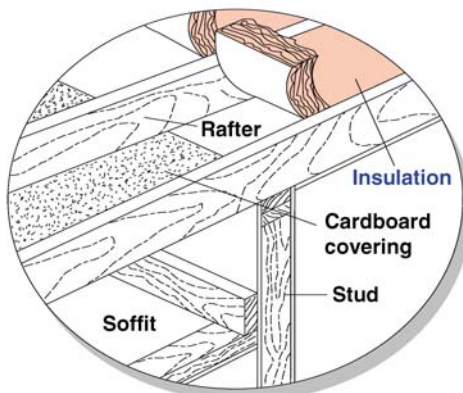
Figure 2-10



## Attic hatches

*Figure 2-10 - Caulk the joint between the hatch frame and the ceiling drywall, and apply foam weatherstripping around the panel edge. Also, install a latching mechanism that will hold the hatch firmly closed. The cam locks used for double hung windows work well, as does a simple hook and eye.*

Figure 2-9



## Drop soffits

*Figure 2-9 - Seal drop soffits in the attic using rigid air barrier materials with caulk or foam.*

## Recessed lighting fixtures

*Figure 2-8 - Recessed lights and electrical junction boxes are difficult air leakage spots. The best (and most expensive) treatment is to replace the fixture with an airtight fixture or retrofit the existing fixture with a new airtight trim piece. Another option is to build an airtight enclosure around the fixture. At a minimum, you should caulk the joint between the fixture and the ceiling drywall.*

**IMPORTANT NOTE OF CAUTION:** Do not build an airtight box over a light fixture unless it is an "IC" (insulated ceiling) rated fixture, meaning that it can be covered with insulation. Also, do not attempt to caulk or tape the fixture itself to stop air leakage. You could create a fire hazard.

## Thermal Bypasses

Thermal bypasses are hidden air paths, chaseways, and passageways that allow heated or conditioned air to bypass or escape through the insulation. Because warm air rises, it will continuously move up these air paths, bypass the insulation, and dump itself into the attic. This not only represents significant heat loss but can also cause indoor moisture problems. The heated air leaking into the attic can result in moisture condensing onto the cooler surfaces in the attic. This can cause ice dams, wet insulation, mold growth, and structural decay.

Common thermal bypasses are located around chimneys, in open exterior and interior walls that are often a result of balloon framing, leaky duct systems, recessed lighting, dropped ceilings and soffits, plumbing and electrical penetrations, vent pipes, and kitchen and bath exhaust fans. These bypasses must be sealed before any attic insulation is installed or added.

Techniques for sealing bypasses depend on the size of the opening. Small holes can be sealed with caulk or foam and larger openings can be sealed by a rigid air barrier - heavy cardboard, plywood, or drywall - in conjunction with a two-part foam sealant.

## Places To Seal

Some holes, such as large attic bypasses, obviously allow air leakage and should certainly be sealed. In other cases it is difficult to tell without a blower door test (see Chapter 1). Minor cracks around molding, for instance, may or may not allow air to leak. If you can't get a blower door test, try feeling for drafts on a windy day.

The most significant loss of heat is usually from the living space up into the attic. Any leaks or bypasses there should be your first priority. Next, deal with any major leaks into the basement or crawl space. Leaks from the living space to the outside through walls and windows, although more conspicuous, allow less actual energy loss and should be your last priority.

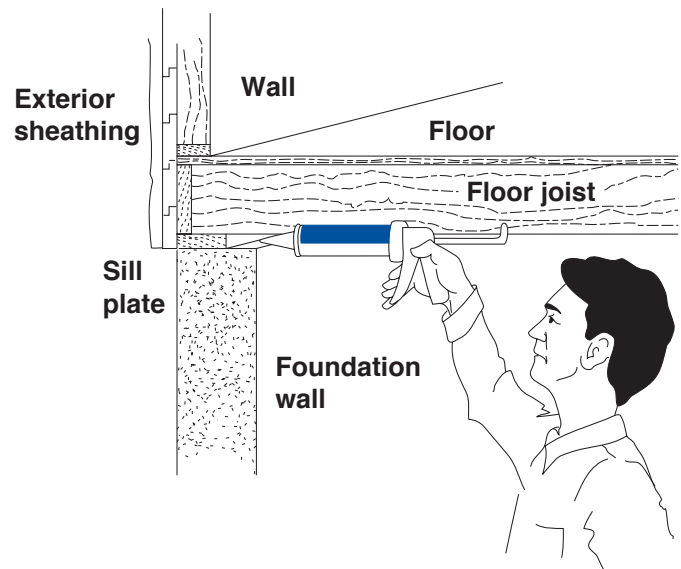
## Attic fans

If you have a whole house attic fan, it should be covered in winter with a tight-fitting cover. Use foam compression weather stripping to seal the cover to the attic

floor. Be sure that when a whole house fan is in operation that sufficient windows are open in the home to prevent the fan from creating a negative pressure and potentially causing a combustion appliance to backdraft. These fans are used in warm weather situations so normally a heating system will not be in operation - but a gas fired water heater is operating all year. Also make sure that the attic is properly vented so that the air that the whole house fan is drawing into the attic will be quickly dispersed to the outside. This will prevent potential moisture problems.

## Basement Work

### Floor-foundation connection



*Figure 2-12 - This is one of the most important areas in the basement for air sealing. If the gaps between the sill plate and foundation are less than 1/4", caulk them with any good resilient caulk. For wider gaps, use one-part urethane foam sealant.*

### Holes or cracks in the foundation

Plug any holes and cracks that penetrate from the outside with caulking, two part foam, or cement.

### Gaps around windows and doors

Seal around basement windows and doors in the same manner as in the upstairs part of the house.

## Service entrances

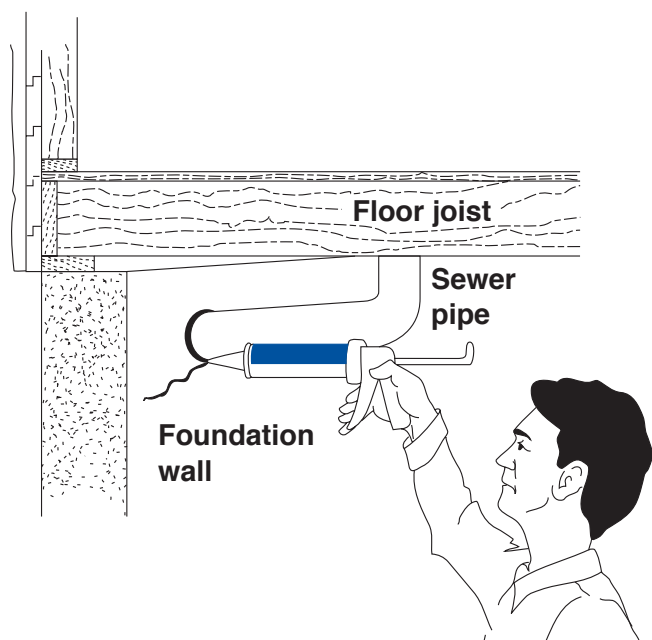


Figure 2-13 - Caulk any gaps around the openings in the basement wall through which services (electrical, plumbing, heating) enter the house.

## Bathtub openings

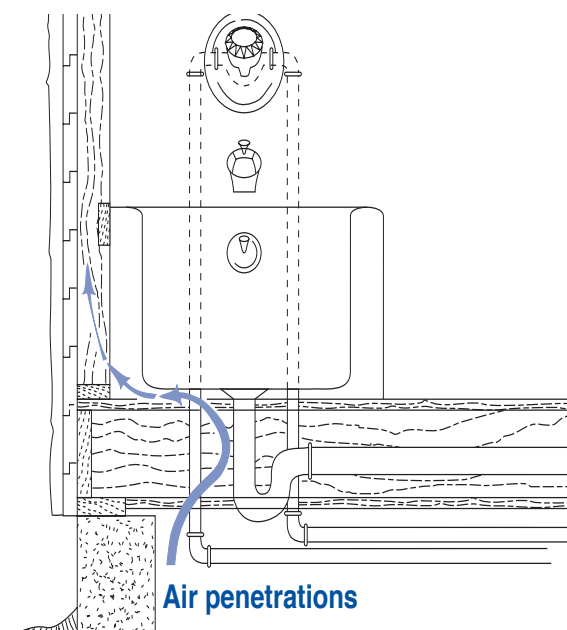


Figure 2-14 - Block air movement up into bathtub openings with stiff cardboard or gypsum board, caulked and nailed to floor members.

## Bottom of balloon-framed walls

Seal the bottom of balloon-framed walls using the same technique as for the tops of open walls in attics (see Figure 2-6, page 24)-- either cardboard, caulked or foamed and stapled, or other rigid air barrier material. Balloon framing is a non-standard house framing method that was very popular many years ago. In balloon framing, the intermediate floor framing joists are face nailed directly to the studs. The studs are continuous from top to bottom of the structure with no wall plates or tops. Balloon framed buildings are very strong and durable because everything is interconnected but this style of framing also creates hidden air pathways and bypasses that reduce the energy efficiency value very significantly.

## Ductwork — a special case (See Chapter 5)

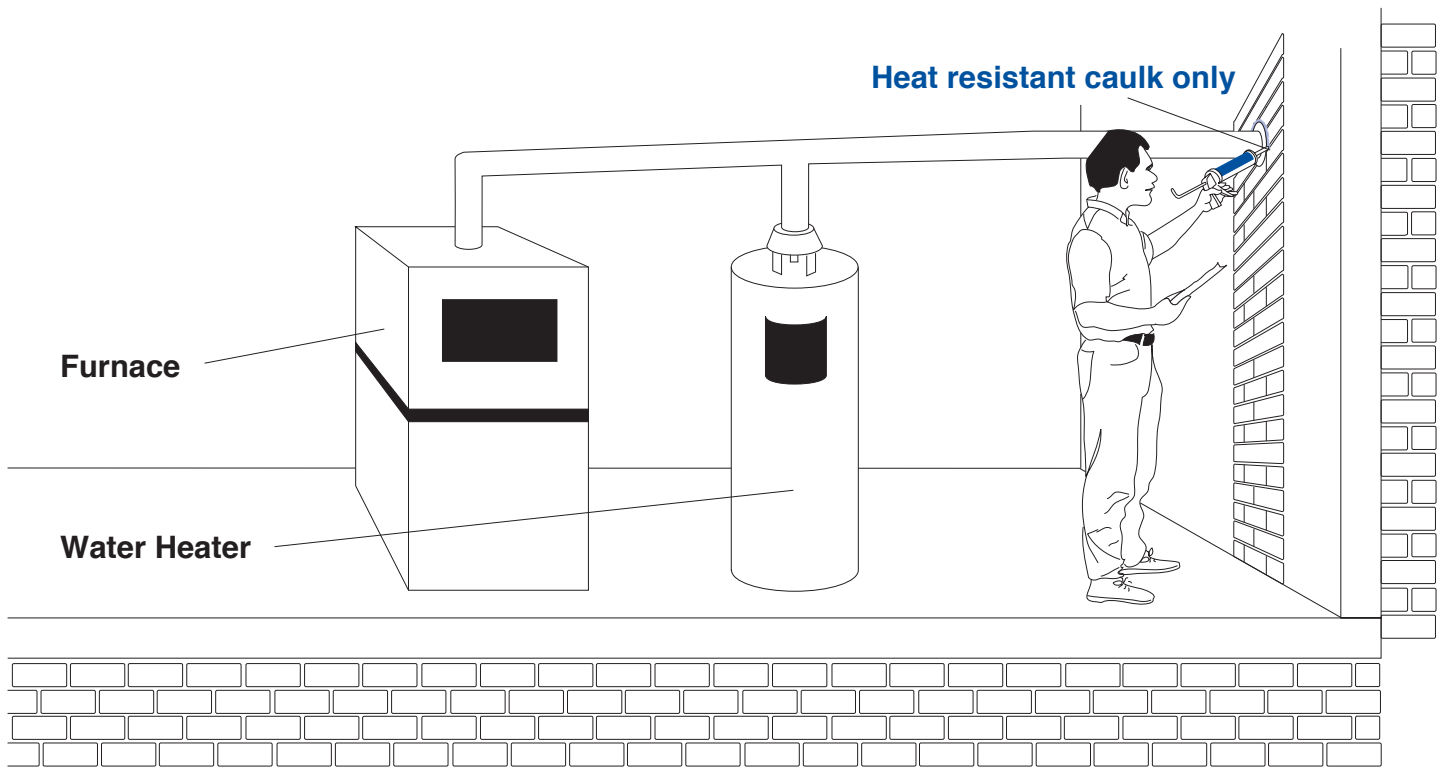
All ductwork should be well-sealed with special mastic. Ordinary gray or silver-colored "duct tape" does not work and won't last (although there are special heat-activated tapes that do work). Also, disconnected or improperly connected ducts should be repaired.

Duct sealing can sometimes upset the pressure balances in a house, causing some natural draft appliances to spill flue gases into the living space. Therefore, you should consult with a professional contractor to make sure there are no potential safety hazards before sealing ducts.

## Unheated Vented Crawl Space

Seal all penetrations through the floor above the crawl space using the same techniques described for the basement ceiling. If the crawl space is to remain vented, there is obviously no need to seal the perimeter walls.

## Water Heater and Furnace Flue Connections



*Figure 2-15 - Seal the connection of the water heater or furnace flue into a masonry chimney with high temperature caulk designed for this purpose or with furnace cement. Do not use any other material.*

## The Living Space

### Inside versus outside - Where to caulk walls

The best place to stop air leakage in exterior walls is at the inside surface of the walls. Although many do-it-yourself manuals recommend sealing around the outside of windows and doors, we now know that air-leakage is more effectively controlled by sealing the interior surface. You may want to seal up cracks on the outside as well to prevent rain from getting into the wall.

### Windows

Replace any cracked or broken glass. Weather-strip only if required. Caulk around interior trim with clear silicone caulk. For extremely leaky windows, the most effective sealing technique is to remove the interior trim and seal the opening between the window frame and rough stud frame with one-part urethane. This, however, is very time consuming. See Chapter 4 for more information on tightening windows.

### Doors

Caulk the threshold if necessary with clear silicone. Also caulk around the door frame, between trim and wallboard. Add a new door sweep to the threshold if necessary.

### Interior baseboard trim

If you know that there is severe air leakage around baseboard trim, the most effective remedy is to carefully remove the trim and seal the wall-floor joint with either caulk or expanding foam. If removing the trim is not practical, then caulk the trim to the wall surface and floor using clear paintable silicone or latex caulk. Air leakage around baseboard trim may be best addressed by determining where the air leakage is coming from and sealing it at the source. This is also the case for severe air leakage around electrical outlets. The best remedy is to identify the source (bypasses, gaps in the rim joist and/or sill plate) and seal these areas.



## Plumbing holes

Caulk gaps around all plumbing penetrations through walls, especially under sinks and behind bathtubs. It is not necessary to seal plumbing penetrations down into the basement.

## Fireplaces

If your fireplace is rarely used, consider installing an airtight plug in the flue to prevent air from escaping up the chimney. Glass doors are another option. Make sure the damper is working and that it is closed when the fireplace is not in use.

If there is a space, caulk the joint where the chimney meets the wall, removing the trim if necessary.

## Radon

Radon is a radioactive gas produced by the decay of uranium, which is present to some degree in all soils. The decay process is a continuous and normal part of nature; radon gas is present at varying levels everywhere except over oceans and lakes.

Radon is invisible and has no smell or taste, even

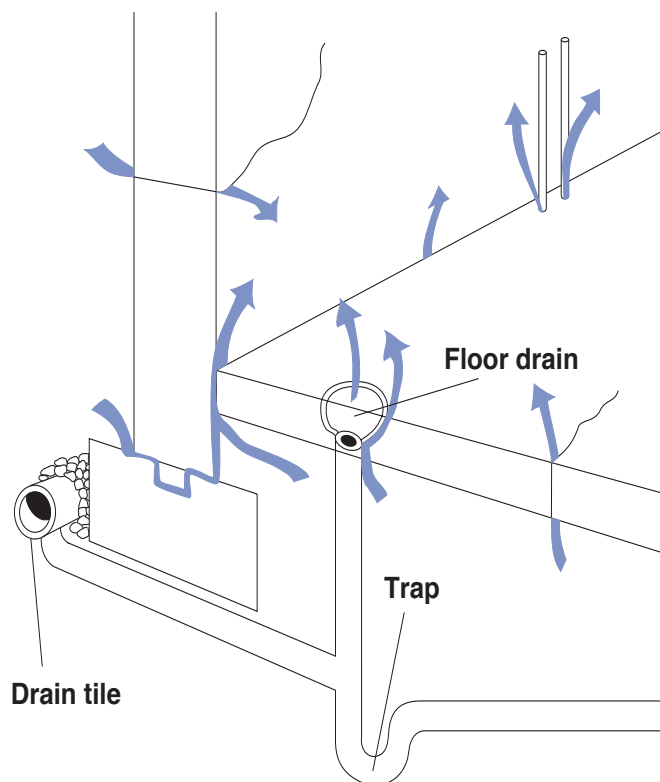


Figure 2-17 - Radon entry points

when it exists at potentially harmful levels of concentration.

Radon is one of many "soil gases" that may be present in different soils in varying amounts. Soil gas enters houses through the areas of the building that are in contact with the ground. Typical entry points include floor drains and cracks in basement walls and floors (Figure 2-17). The amount of radon that accumulates in any particular house depends on a number of factors, including the concentration of radon in the surrounding soil, the type of soil, the way the house is constructed, the rate of soil gas entry, the rate of air exchange within the house, and even the time of day or season of year.

Radon is also present in groundwater and can be brought into a house through the plumbing system. This is sometimes a problem in rural areas with high radon concentrations in well water. Municipal water systems generally have low levels since any dissolved radon usually has enough time to decay or escape.

Building materials such as concrete, brick and stone were once thought to be a major source, but the amounts of radon released are usually insignificant.

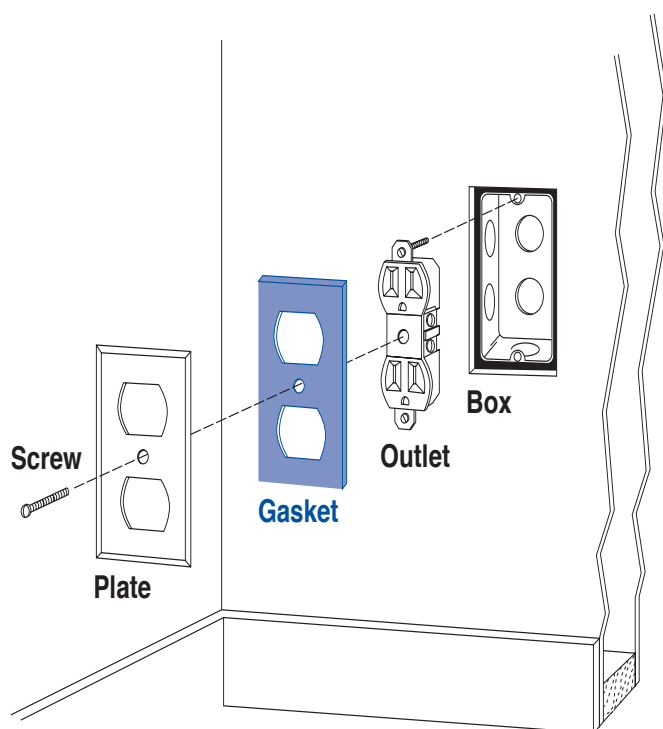


Figure 2-16 - Install gaskets behind cover plates in all electrical outlets and switches, including those on interior walls. Turn off power before installing gaskets.



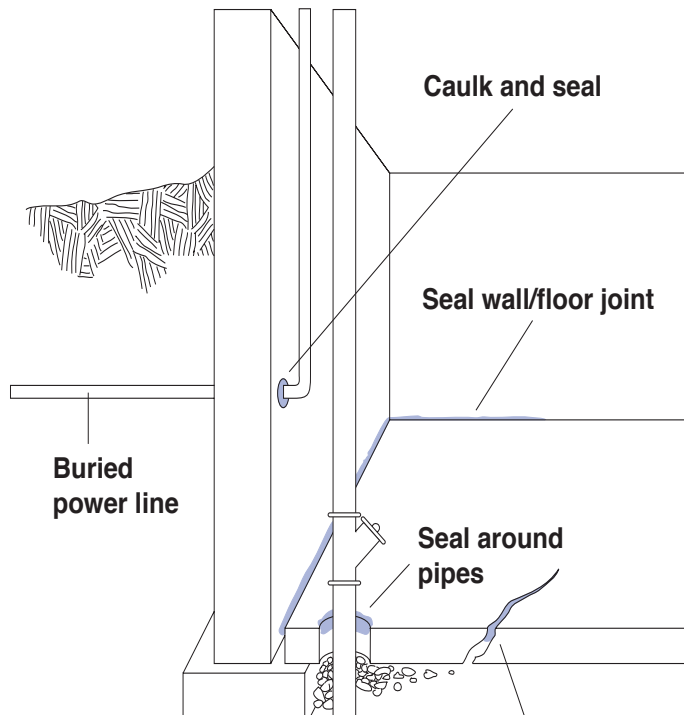


Figure 2-18 - The first step in radon control is to seal entry points in basement.

## What to do about radon

Regardless of whether you perform any energy-efficiency improvements on your home, you may want to have it tested for radon. Several types of simple inexpensive tests are available from EPA (Environmental Protection Agency) certified contractors.

Typically a small detector canister is left exposed in the house for anywhere from a few days to a few weeks. After exposure, the canister is sent to a laboratory for analysis. If the measured radon levels are considered high, a more sophisticated test is performed. If the high levels are confirmed, the remedial work to reduce radon entry is called for.

## Energy Tips and Recommendations

1. Before you begin any air sealing measures in your home, make sure that all combustion appliances are drafting properly and are vented correctly and safely to the outside.
2. After you have completed any air sealing work be sure that all combustion appliances are drafting properly.

3. Make sure that all combustion appliances are tested for carbon monoxide. Install a UL-rated carbon monoxide detector in the appropriate place in your home.
4. Consider any existing or potential indoor air quality problems before tightening your home. If you have any mold growth in the home, remove it and find and correct any water or moisture problems that are allowing the mold to grow.
5. Remove any unvented space heaters before any air leakage work is done.
6. Inspect all exhaust fans for proper operation and replace them if they are defective.
7. Use a blower door to identify air leakage areas and to measure the air tightness of your home after the air sealing work is done.
8. If necessary install mechanical ventilation in your home.
9. Locate and seal all thermal bypasses that may exist.
10. Have your home tested for radon.
11. Seal leakage areas in the attic, basement, crawl space, around windows and doors, all plumbing and electrical penetrations, tops and bottoms of balloon-framed walls, unused fireplaces, and existing furnace flue connections.